

2/PRTS

Method for coating a support plate
and fuel cell provided with such a support plate

5 The present invention relates to a method for coating a non-oxidised stainless steel support plate with an electrically conducting corrosion-resistant coating, comprising applying a diffusion barrier layer containing a titanium compound, followed by applying a nickel layer. A method of this type is disclosed in German Offenlegungsschrift 19523637. High demands are imposed on that part of the fuel cell which is located on the anode side. On the one hand this must be capable of discharging the stream supplied via the gas distribution device on the
10 anode side. On the other hand this must be sufficiently corrosion-resistant to meet current requirements in respect of service life. Currently a service life of a few ten thousand hours is required. Because of the aggressive environment resulting from carbonate material, high temperature and the relatively low potential at the anode, this side of the separator plate is particularly severely stressed.

15 In order to avoid the corrosion problems it is proposed in the abovementioned German Offenlegungsschrift to apply a coating, consisting of a titanium nitride layer on top of which a nickel layer has been applied, on the anode side of the stainless steel separator plate. This nickel layer provides protection but the base material from the stainless steel must be prevented from diffusing into the nickel. After all, it has been observed that the strength of
20 the residual nickel layer decreases appreciably as a result of such a diffusion process and within 10 000 hours the residual nickel layer detaches from the stainless steel layer and the cell rapidly becomes inoperative. According to German Offenlegungsschrift 19523637, the thickness of the titanium nitride layer is preferably between 0.5 and 5 μm . It is assumed that the titanium nitride is converted to titanium oxide by contact with the carbonate material.
25 However, it has been found that this oxide has a larger volume and consequently locally pushes away the nickel layer. Moreover, it has been found that a titanium oxide layer obtained in this way is not impermeable and attack on the base material can consequently not be prevented.

30 In German Offenlegungsschrift 4030943 an anode made up of porous nickel and titanium oxide is described. On contact with lithium carbonate lithium titanate is produced, which promotes moistening of the porous nickel anode because carbonate material penetrates into the anode more easily. The separator plate or bipolar plate is nickel-coated and consists of stainless steel material.

The aim of the present invention is to provide a method for coating a separator plate of a fuel cell wherein a diffusion barrier layer is used which remains intact even after prolonged operation and wherein the corrosion-resistant nickel layer arranged thereon is not affected.

This aim is achieved with a method as described above in that said titanium compound
5 comprises titanium oxide.

As a result of applying titanium oxide directly to the stainless steel base material, no harmful reaction takes place when carbonate diffuses through the porous nickel top layer. It is assumed that TiO_2 in contact with the carbonate converts the top layer into Li_2TiO_3 . This does not have any adverse effect on the electrical properties of the coating. The bulk of the
10 TiO_2 is converted into a sodium-titanium bronze or a potassium-titanium bronze. This material still has barrier properties relative to the alloy elements from the stainless steel. A further guarantee that the barrier layer remains intact even during a prolonged period is achieved by giving the layer an appreciable thickness. Preferably the thickness is at least 25 μm and more particularly is between 40 and 50 μm .

The titanium oxide layer described above can be applied in any way known from the prior art. Examples are application of a plasma spray under atmospheric pressure or high velocity oxygen flame spraying, sputtering, vaporisation using an arc, adhesion and sputtering using an arc, ion plating or CVD.
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According to a further advantageous embodiment of the invention the titanium oxide is
20 applied to the stainless steel support only after an adhesion layer, such as a layer of NiCrAlY , has been placed thereon.

As described above, the invention is used in particular for a fuel cell in which the separator plate or bipolar plate on the anode side has been treated as described above. It must be understood that the method described above can be used in other applications under
25 aggressive conditions where electrical conduction is required.

The invention will be explained below with reference to an illustrative embodiment shown in the drawing, in which the various components are not shown on the same scale. In the drawing:

Fig. 1 shows, diagrammatically in cross-section, part of an MCFC cell close to the
30 separator plate according to the invention; and

Fig. 2 shows, in detail in cross-section, part of a separator plate facing the anode.

Fig. 1 shows part of an MCFC cell provided with a separator plate 7 which is adjoined

by a gas distribution device 4 on the anode side, with which current collector 8 is in contact, which is adjoined by an anode 5. Both the anode and the corrugation can be made of nickel material. The anode consists more particularly of nickel containing 10 % (by wt.) Cr.

5 The separator plate 7 is shown in detail in Fig. 2. This separator plate consists of a support of stainless steel material, such as 3 AISI 310 having a thickness of, for example, 0.5 mm. An adhesion layer 6 composed of a metal chromium aluminium yttrium alloy, such as NiCrAlY, is applied on top of this. The thickness of this layer is approximately 40-60 μm . The adhesion layer material can be applied in powder form by using as the starting material an NiCrAlY powder having a particle size of between 10 and 45 μm , which is applied using the HVOF spraying technique.

10 An adhesion layer of this type is applied in order to compensate for the difference in the coefficient of expansion between stainless steel and the titanium oxide layer. Before applying such an adhesion layer to the stainless steel support material, the stainless steel material can be roughened by any method known from the prior art. For example roughening takes place by means of grit blasting with fine Al_2O_3 grit.

15 A titanium oxide layer having a thickness of between 40 and 50 μm is then applied thereon using the high velocity oxygen flame spraying technique. This layer is indicated by 2. The starting material used for this layer is a powder having a particle size of between 5 and 20 μm . This powder can optionally be doped with a pentavalent ion, in particular with niobium or tantalum. Niobium is the most preferred. The porosity of the titanium oxide layer is typically 2 %. A nickel layer 3, having a thickness which is likewise between 25 and 20 μm , is applied on top of said titanium oxide layer by any method known from the prior art. In this case also the HVOF spraying technique is preferably used.

25 In tests under corrosive conditions with the potential applied to the anode, as is to be expected in use, no substantial attack on the stainless steel base material was detected at a temperature of approximately 650 °C after 3 000 hours. On the basis of this it can be extrapolated that a service life of more than 40 000 hours is achievable.

30 Although the invention has been described above with reference to a preferred embodiment, it must be understood that modifications can be made thereto which are immediately obvious to those skilled in the art after reading the above description and are within the scope of the appended claims.